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Firm-level exchange exposure in the Eurozone

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Abstract

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Key words: foreign exchange exposure, euro, Eurozone, economic openness

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1. Introduction

One of the purported benefits of a single currency zone is that foreign exchange risk is eliminated for intra-zone trade and investment, reducing uncertainty for firms operating across national borders (Eichengreen, 1990). For the Eurozone specifically, the elimination of exchange risk has been cited in various EU policy documents as an important benefit of Eurozone membership (see, for example, EU, 1995 and EU, 2007). With the Eurozone now approaching 10 years old, it is timely to look at Eurozone firms' exchange exposure; a topic that has received surprisingly little empirical attention. We examine the issue by comparing the exchange exposure of a sample of Eurozone and non-Eurozone European firms. Our data set comprises 1,154 firms from 11 European countries: 7 Eurozone members – Belgium, France, Germany, Italy, the Netherlands, Portugal and Spain, and 4 non-Eurozone countries – Norway, Sweden, Switzerland and the UK.

In the first stage of our research, we estimate firm-level exchange exposure in two periods: the pre-euro period from January 1990 to December 1998, and the post-euro period from January 1999 to January 2008. This is conducted using the technique pioneered by Jorion (1990) that has become standard in the exchange exposure literature, involving a time-series regression of changes in the trade-weighted exchange rate against the return on a firm's stock, while controlling for market effects. We find that exchange exposure increased after the introduction of the euro for both Eurozone[1] and non-Eurozone firms, and also that Eurozone firms have higher exchange rate exposure than non-Eurozone firms. Although exchange exposure increased from the pre-euro to the post-euro period for firms within and outside the Eurozone, the increase was smaller for Eurozone firms, and this is weakly supportive of the benefits of Eurozone membership alluded to above. However, our apparently anomalous findings prompt further investigation. If firm-level or 'idiosyncratic' exchange exposure has increased, what has happened to exposure at the level of the market? In the second stage of our analysis, we find that market-level exposure has declined in Eurozone countries by more than it has outside the Eurozone.

In the third stage of our research, we investigate why firms in the Eurozone continue to have higher exchange exposure than firms in our sample non-Eurozone countries. Using the exchange response coefficients estimated from the firm-specific time-series regressions as the dependent

[1] This is in contrast to Bartram and Karolyi (2006), who found a reduction in exchange exposure after the advent of the euro, although this was economically and statistically small. Bartram and Karolyi's data set, however, extends only to the end of 2001.

variable, we run cross-sectional regressions to determine whether this difference can be explained by country-level and firm-specific factors that have been found in prior studies to explain exchange exposure. The country-level factors are economic openness, shareholder rights and creditor rights; and the firm-specific factors are size, industry, and four financial ratios: debt-to-assets, market-to-book, quick ratio, and dividend payout ratio. After controlling for these characteristics, we find no difference between the firm-specific exchange exposure of firms within and outside the Eurozone.

The remainder of this paper is structured as follows. In section 2 we describe our approach to estimating firm-level exchange exposure and present our data set. Sections 3 and 4 present our findings on firm-level and market-level exchange exposure respectively. In section 5 we discuss and present our findings on the firm-level pooled cross-sectional analysis, and section 6 provides concluding comments.

2. Method and data

Our sample comprises firms from 7 Eurozone members: Belgium, France, Germany, Italy, the Netherlands, Portugal and Spain; and 4 non-Eurozone countries: two EU members (Sweden and the UK) and two non-EU European countries (Norway and Switzerland). Our exchange rate data are IMF monthly nominal effective trade-weighted exchange rates from January 1990 to January 2008 (sourced from Datastream), with an increase in the exchange rate index indicating an appreciation of the currency. Our stock price and market index data are also from Datastream, and the index data are Datastream weighted indexes for each country. We divide the data into two nearly-equal time periods: January 1990 to December 1998 and January 1999 to January 2008. Summary information on the exchange rates and the exchange rate arrangements of our sample countries is presented in Table 1. We report the mean and standard deviation of the exchange rate log change for each period. As expected, exchange rate volatility (as measured by standard deviation of the log change) falls for the Eurozone countries after the introduction of the euro, from an average of 1.02 to 0.65. Volatility also falls for the Swedish, Swiss and UK currencies, but it rises substantially from the 1990s to the 2000s for Norway. This may be because Norway switched from a managed float (in place from 1992 to 2001) to an independent float in 2002.

Adler and Dumas (1984) suggested that the foreign exchange exposure of a firm can be quantified by measuring the sensitivity of equity returns to exchange rate changes. An extensive body of work has subsequently examined the relation between exchange exposure and firm value using this and similar approaches, although it has mostly been operationalised via Jorion's (1990) technique of measuring the sensitivity of equity returns to exchange rate changes while controlling for market movements:

$$r_t^{i,j} = \alpha_0^i + \alpha_1^i R_t^j + \alpha_2^i s_t^j + e_t^i \qquad [1]$$

Here, $r_t^{i,j}$ is the log difference return on stock *i* in country *j* and R_t^j is the return on country *j*'s benchmark stock index for time period *t*, with each measured in local currency, and s_t^j is the log difference change in country *j*'s trade-weighted exchange rate index over the same time period. This 2-factor model is generally considered superior to Adler and Dumas' (1984) specification which omits the market factor. The inclusion of a market index is designed to control for the macroeconomic effects of exchange rate movements; exchange rates and stock prices may move together simply because they are driven by the same shocks. The coefficient on the exchange rate variable α_2^i therefore measures idiosyncratic (or 'residual') exchange exposure for firm *i* (Jorion, 1990).

A firm is subject to economic (or operating) foreign exchange exposure if changes in exchange rates affect expected future cash flows, and therefore firm value. This includes transaction exposure, involving known foreign currency receivables or payables, and indirect economic exposure (sometimes referred to as competitive exposure) which arises when suppliers or competitors are directly exposed. While the former is straightforward to hedge using currency derivatives, economic exposure is hard to measure and can be difficult and costly to hedge, and it is in eliminating this type of exposure that the greater benefits of Eurozone membership would arise. In early studies of firm-level exchange exposure, samples often comprised firms with a certain minimum proportion of export sales, on the basis that firms with international transactions are likely to be more exposed than those without (see, for example, Jorion, 1990; Donnelly and Sheehy, 1996; Chow, Lee and Solt, 1997; He and Ng, 1998). However, not only does theory relating to exchange exposure suggest that it extends beyond international transactions, but as Dominguez and Tesar (2001a) argue, firms with indirect exchange exposure may be more exposed than those with direct exposure, since the latter are more likely to hedge foreign exchange transactions, and because they are more likely to have natural hedges in place, such as

FDI. This contention receives some support from Miller and Reuer's (1998) finding that FDI has a negative effect on a firm's exchange exposure while export intensity has no effect. Further, Pantzalis, Simkins and Laux (2001) found that firms that operate across a greater number of countries are associated with less exchange exposure. Our data set comprises 1,154 firms with stock price data available on Datastream for the period January 1990 to January 2008. Numbers for each country and other information about the sample firms can be found in Table 2, which is discussed in detail in the next section. We estimate the model in equation [1] for each of our sample firms using robust regressions with Newey-West standard errors.

3. Firm-level exchange exposure

Table 2 summarises our results from estimating equation [1] on the full data set of 1,154 firms for the two sub-periods pre-euro (columns [2] to [7]) and post-euro (columns [8] to [13]). It presents summary information on the exchange response coefficients (α_2^i) for each country, for the Eurozone and the non-Eurozone firms, and for the sample overall. It reports the number of exchange exposure coefficients (α_2^i) that are negative, the number and proportion significant, the count significantly negative and significantly positive (at the 5 percent level or better), and the median absolute exchange exposure response coefficient, $\left|\alpha_2^i\right|$. Rather than using the actual exchange exposure response coefficients we follow Dominguez and Tesar (2001a and 2001b) and take the absolute values of the α_2^is. This is because the impact of exchange rate changes will vary between firms, yielding both negative and positive response coefficients. For net exporters, for example, a depreciation of the home currency (making exports more competitive) should increase firm value, while for net importers a depreciation should reduce value.[2]

We find that 121 of our firms pre-euro (10.5 percent) and 122 post-euro (10.6 percent) have significant exchange exposure after controlling for market effects. The country with the highest proportion of significantly exposed firms in both periods is Switzerland, with more than a quarter of Swiss firms significantly exposed. Swiss firms also have the greatest proportion of negative

[2] In conducting our analysis on the absolute value of the exchange exposure response coefficients, an important question arises: is there an asymmetry between positive and negative response coefficients? For example, are firms with negative coefficients more exposed in an absolute sense than firms with positive exchange exposure? We check for differential exposure magnitude by dividing the significant exposure coefficients into positives and negatives, and testing whether these are significantly different in an absolute sense. The median of the (absolute) negative coefficients is 1.94 and for the positives 2.01. This difference is not significant using a Wilcoxon rank sum test (p = 0.77).

exchange response coefficients relative to positive – a relation that would be expected for net exporters or firms with assets denominated in other currencies. Germany has the lowest count of significantly exposed firms in the pre-euro period, and Sweden has the lowest in the post-euro.

It is clear from Table 2 that for firms in most countries, exchange exposure increased between the pre and post-euro periods. Columns [14] and [15] summarise this information; [14] is the difference in the median absolute exchange exposure coefficient, and [15] contains the p-value for a Wilcoxon rank sum test of difference. None of the Eurozone countries experience a significant decline in median exchange exposure. Median exposure falls for Belgium and the Netherlands, but these are small, insignificant reductions. The only significant reduction in median exchange exposure occurred amongst Norwegian firms; the median fell from 1.00 to 0.61, and this is significant at the 5 percent level (p=0.05). Of the remaining countries – whose median absolute exchange exposure coefficient increased from the pre- to the post-euro period – the increase is significant for German, Italian, Portuguese, Spanish, Swiss and UK firms. In fact, for 4 of our 7 Eurozone countries, firm-specific exposure increased significantly after the introduction of the euro. Another interesting change from pre to post-euro is that a reasonably even split between significantly negative and significantly positive (24 positive and 35 negative) exposure coefficients for Eurozone firms in the pre-euro period switches to a majority positive exposure (49 positive versus 15 negative). The vast majority of Eurozone firms that are significantly exposed have values that increase when the euro rises – a phenomenon that would be expected of net importers. In contrast, the split of significant positives and negatives from period to period for the non-Eurozone firms remains almost the same.

Consistent with expectations, more non-Eurozone firms are significantly affected by exchange exposure in both periods. In the pre-Eurozone period, 8.4 percent of Eurozone firms are significantly exposed versus 13.7 percent of non-Eurozone, and in the post-Eurozone period the figures are 9.1 percent and 12.8 percent. These differences are significant at standard levels using a z-test for difference in proportions (p = 0.00 and 0.04 for the pre-euro and post-euro periods respectively). Although the proportion significant is higher for non-Eurozone firms, the median exchange exposure coefficients display the opposite pattern: in both the pre-euro and post-euro periods, the median exchange exposure coefficients are higher for the Eurozone firms. In the pre-euro period, the mean absolute response coefficient for the Eurozone firms is 0.58 and the non-Eurozone 0.46, and in the post-euro period, the equivalent figures are 0.80 and 0.66. These differences are significant using a Wilcoxon test (p = 0.00 for the pre-euro comparison and p =

0.01 for the post-euro period; not reported in the table). In the pre-euro period, Eurozone firms are about 26 percent more exposed than non-Eurozone, and in the post-euro period the equivalent figure is 21 percent. So while firm level exposures rises for both Eurozone and non-Eurozone firms after the introduction of the euro, exposure for non-Eurozone firms increases more.

4. Market-level exchange exposure

Recall that by estimating exchange exposure via the common method of equation [1], we control for market effects. What is happening to exchange exposure at the market level? Perhaps the effect of the euro's introduction is systematic in nature; the increase in firm-level exposure may be offset by a reduction in exchange exposure at the market level.

We estimate the following equation:

$$R_t^j = \beta_0^j + \beta_1^j s_t^j + \varepsilon_t^j \qquad [2]$$

Here, the change in country *j*'s trade-weighted exchange rate index (s_t^j) is regressed on the stock market index in country *j* (R_t^j), and the coefficient β_1^j measures the extent of market-level foreign exchange exposure in country *j*.

In Table 3 we present the findings from estimating equation [2] to determine the foreign exchange response coefficients β_1^j for each of our 11 national stock markets in the pre-Eurozone and post-Eurozone periods. In the pre-euro period, all of the Eurozone markets except Spain are significantly exposed to exchange rate movements, whereas our four non-Eurozone countries' markets are not significantly exposed at standard levels. The advent of the euro appears to have had the effect for the Eurozone countries of reducing market exposure to exchange rate movements; all are now insignificantly exposed. The non-Eurozone markets remain insignificantly exposed to exchange rate changes, except for Switzerland whose marginally significant exposure in the pre-euro period (p = 0.10) becomes significant (p = 0.01). This pattern is consistent with membership of the Eurozone leading to a reduction in exposure to exchange rate changes at the market level. With the exception of Italy and Spain, the Eurozone markets' exchange exposure falls in absolute terms, and so does the exposure of Norway and Sweden. Exchange exposure for Switzerland rises, and the UK's stays about the same. It is clear,

therefore, that an increase in firm-level exchange exposure is offset by a reduction of systematic or market-level exposure.

5. The determinants of firm-level exchange exposure

Our finding that the absolute exchange exposure for Eurozone firms is significantly higher than for non-Eurozone European firms after the advent of the euro warrants further investigation. In this section we conduct pooled cross-sectional regressions using the exchange exposure coefficients α_2^i estimated via equation [1] to address the question, can this difference be explained by fundamental factors specific to the country or the firm?

5.1 Country-specific variables

Economic openness

A potential explanation for the weak findings associated with prior studies of firm-level exchange exposure is that the US is not a particularly open economy, and most studies have been conducted using US data. Several studies looking at single or a few countries (Bodnar and Gentry (1993) Donnelly and Sheehy, 1996; He and Ng, 1998; Chen, Naylor and Lu, 2004; Glaum, Brunner and Himmel, 2000; Nydahl, 2001; see Muller and Verschoor, 2006a for a review) point to the possibility that an economy's openness influences the degree of exchange exposure, and Friberg and Nydahl (1999) found a significant positive relation between market-level exchange exposure and openness. Hutson and Stevenson (2008) find a robust positive relation between economic openness and firm-level exchange exposure for a large sample from 23 countries.

We use the common measure of economic openness: trade openness, defined as exports plus imports as a percentage of GDP. We obtain our trade openness figures from the Penn World Table Version 6.2, which is a recent release that provides openness figures up until 2004[3], and use the average of these annual figures for the period 1999-2004. When looking at the possible relation between openness and exchange for Eurozone countries, it is appropriate to use a measure of extra-Eurozone trade openness rather than total trade openness. This is because a large proportion of these countries' trade is with other Eurozone countries, and this trade is not

[3] Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006. (http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php).

subject to exchange exposure. Using Eurostat data, we estimate the proportion of exports and imports for each Eurozone country with trading partners outside the Eurozone, and amend the Penn openness measures accordingly.[4]

Trade openness for our sample countries is depicted in Figure 1. The Eurozone countries' openness figures are depicted on the left-hand-side of the figure, and on the right-hand-side are the non-Eurozone figures, each ranked from left to right on overall openness. For the Eurozone countries we also plot our estimate of extra-Eurozone trade openness. On the standard measure of openness, Belgium and the Netherlands are by far the most open, with an average exports plus imports at 166 and 135 percent of GDP respectively. The other countries have openness figures of less than 100 percent, and the openness of non-Eurozone Sweden, Switzerland and Norway very similar at 85, 85 and 76. Most of the Eurozone countries – with the exception of Germany and Italy – trade mainly within the Eurozone. For Portugal, for example, only 33 percent of trade is outside the Eurozone. Germany has the largest proportion of trade with non-Eurozone countries at 55 percent. Clearly, the extra-Eurozone measure of openness reduces the apparent openness of the Eurozone countries considerably, and this is particularly evident for Belgium and the Netherlands.

Hedging

Several studies have shown that hedging activities reduce exchange exposure (Allayannis and Ofek, 2001; Nydahl, 2001; Pantzalis, Simkins and Laux, 2001). As our approach to estimating firm-level exchange exposure (equation [1]) detects the exposure that remains after the firm has conducted its risk management activities, we include in our cross-sectional regressions two country-specific factors that potentially affect the incentives faced by managers to hedge their foreign exchange risk: shareholders' rights and creditors' rights. We also use several firm-specific factors that have been suggested to influence managers' hedging decisions; these are discussed in section 5.2 below. Several theories explain how firms can add value by hedging. By

[4] It is not straightforward to compile data on extra-Eurozone trade. The most recent detailed data on EU trade is available in the Eurostat statistical yearbook *External and intra-European trade, data 1958-2006*, which breaks down EU and extra-EU merchandise trade by country. Unfortunately, the year book does not aggregate extra-*Eurozone* trade. To estimate extra-Eurozone trade, for each country in our sample we summed the exports and then imports for its Eurozone trading partners. We then subtracted this sum from the year book's figures on intra-EU exports/imports, and added this to the figures on extra-EU exports/imports. This yielded an estimate of extra-Eurozone merchandise trade. We multiplied the proportion of trade for each country that is extra-Eurozone (average for the period 1999-2004) by our original openness figures from the Penn world table, to yield an estimate of average extra-Eurozone openness. It is unfortunately still a rough proxy because the Eurostat data cover only merchandise trade.

reducing the volatility of expected future cash flows, the likelihood of a firm encountering financial distress falls, reducing expected financial distress costs (Smith and Stulz, 1985). Myers (1984) and Leland (1998) also suggest that a reduction in the likelihood of financial distress also facilitates an increase in debt capacity, giving firms a greater tax benefit of debt. Froot, Scharfstein and Stein (1993) suggeset that hedging increases firm value because it reduces the likelihood that the firm will need to tap external capital markets (and encounter associated information asymmetry problems) to obtain finance. Allayanis and Weston (2001) find a significantly positive relation between a firm's use of foreign exchange derivatives and equity value, and Allayanis, Lel and Miller (2003) find that this 'hedging premium' is greater for firms in countries with superior protection of minority shareholders. Lel (2006) finds that firms in countries with better shareholder protection are more likely to use derivatives, and he also finds that derivative use is more likely to reduce risk when corporate governance is strong. The findings of Allayanis, Lel and Miller (2003) and Lel (2006) support the shareholder value theories of hedging, and they also suggest that managers may neglect to put in place value-enhancing hedging strategies in countries in which minority shareholders are weakly protected. We use La Porta et al.'s (1998) aggregate measure of shareholder rights (they use the term 'antidirector rights') as our proxy for the strength of shareholder rights in each country. We anticipate an inverse relation between shareholder rights and firm-level exchange exposure; that is, we expect firms to be less exposed in countries with strong shareholder rights because their managers are more likely to hedge.

If hedging reduces the likelihood of a firm encountering financial distress or entering bankruptcy, there are implications for creditors as well as shareholders (Smith and Stulz, 1985). Strong creditor protection implies that creditors' claims against the firm are maximally protected in bankruptcy proceedings against the claims and rights of management and owners. Shareholders of firms in countries with strong creditor protection will therefore encounter relatively high costs of bankruptcy, so it is important for firms in these countries to hedge. Allayanis, Lel and Miller (2003) find that as with shareholder rights, firms in countries with strong creditor rights have a higher 'hedging premium', and Hutson and Stevenson (2008) find a robust inverse relation between creditor rights and exchange exposure. We use La Porta et al.'s (1998) aggregate measure of creditor rights as our proxy for the strength of creditor rights in each country. The implication for exchange exposure is the same as for shareholder rights; we expect that firms in countries with strong creditor rights will have lower exposure because they face a greater incentive to hedge foreign exchange risk.

5.2 Firm-specific variables

Size

It is well established that small firms tend to be more exposed to exchange rate movements than large firms (Chow, Lee and Solt, 1997; Bodnar and Wong, 2003; Hunter, 2005; Dominguez and Tesar, 2006), and there are at least two reasons why this might be the case. *First*, larger firms are more likely to hedge currency exposure because hedging activities exhibit economies of scale (Bodnar, Hayt and Marston, 1995, 1996, 1998; Berkman, Bradbury and Magan, 1997; Geczy, Minton and Schrand, 1997; Nance, Smith and Smithson, 1993; Allayanis and Ofek, 2001; Hagelin and Pramborg, 2006). *Second*, large firms are more likely to be multinational (Agarwal and Ramaswami, 1992), and firms that operate across a greater number of countries are associated with less exchange exposure (Pantzalis, Simkins and Laux, 2001). Dominguez and Tesar (2006) and Hutson and Stevenson (2008) show that this relation may be nonlinear. We define small firms as those below US$150 million, and according to this definition there are 517 small firms (45 percent) in our sample. We use a zero-one dummy to capture potential non-linearities in the relation between exchange exposure and firm size, with 1 for small firms.

Industry

Eurozone countries may have different industrial structures to non-Eurozone, which may in part explain the differences in exposure that we find. Many studies have found that industries are affected differentially by exchange exposure (for example, Bodnar and Gentry, 1993; He and Ng, 1998), and there are two main reasons for this. *First*, some industries may be more likely to have international transactions, such as importing inputs or exporting finished goods, while for others such as utilities direct exchange exposure might be small. Bodnar and Gentry (1993), for example, find that between 20 and 35 percent of industry sectors have statistically significant exchange rate exposure, while Griffin and Stulz (2001) find little significant exposure at the industry level. This may be because firms in the sectors with a greater quantity of international transactions are more likely to hedge, and this was suggested by Dominguez and Tesar (2001b) as an explanation for their finding that trade, measured at the industry level, has little effect on firm-level exchange exposure. *Second*, industries will be exposed to different levels of competitive exposure. Firms in some industries may be able to pass on to their customers increased costs or prices that result from exchange rate movements, while others will have less flexibility to do so.

Bodnar, Dumas and Marston (2002) suggest that the more competitive the industry and the less differentiated the product, the greater the exchange exposure.

Our 11 industry categories are formed on the basis of two and three-digit NAICS codes (the precise details of which are included in the notes to Table 4). The industries are: *chemicals*; *commodities and metals*; *construction and building products*; *high-technology manufacturing*; *low-technology durables manufacturing*; *non-durables manufacturing*; *services*; *textile clothing and footwear*; *telecoms, media and information*; *utilities*; and *wholesale, retail and transportation*. Table 4 provides information on industry, including industry-specific mean and median absolute exposure coefficients (α_2^i estimated via equation [1]). The largest industry category is *low-tech durables manufacturing* with 299 firms, and the smallest is *commodities and metals* with 32. In terms of proportion of each industry category in the Eurozone versus non-Eurozone countries, there are no industries that are concentrated in one category or the other, except perhaps for *textiles, clothing and footwear* which has a bigger presence in the Eurozone countries. The industries that are the most exposed are *high-technology manufacturing*, *services*, and *textiles, clothing and footwear*, and the lowest levels of firm level exposure are experienced by firms in the *utilities* industry. We control for industry using zero-one dummies in our pooled regression analysis.

Financial statement variables

We include several firm-specific factors that have been found to affect managers' incentives to hedge: leverage (debt-to-assets), market-to-book, the quick ratio, and the dividend payout ratio. Leverage is a common proxy for the likelihood of financial distress. Being a major 'fixed claim' against the cash flows of the firm, hedging becomes more valuable as leverage rises (Nance, Smith and Smithson, 1993). Further, potential underinvestment (Myers, 1977**;** Froot, Scharfstein and Stein, 1993) is more of a problem in high debt firms. Other things being equal, the theories of hedging imply that firms with higher leverage have lower levels of exposure. He and Ng (1997) found a strongly significant negative relation between leverage and exchange exposure for their sample of Japanese firms, but Muller and Verschoor (2006b) found a negative (although insignificant) relation for European firms. We use the long-term debt-to-assets ratio[5] as the measure of firm-specific leverage.

[5] Long-term debt and total assets are from Datastream (wc03251 and wc03501).

The model of Froot, Scharfstein and Stein (1993) predicts that firms with particularly costly external financing, such as those with considerable greater growth opportunities or firms whose assets are largely intangible (Titman and Wessels, 1988), benefit the most from hedging. A common proxy for growth opportunities is market-to-book value of equity. He and Ng (1997), who include market-to-book as an independent variable in their study of Japanese firms' exposure, find weak evidence that firms with high market-to-book ratios have lower exchange exposure. Our measure of growth opportunities is the market value of equity to book value of equity.[6]

Nance, Smith and Smithson (1993) suggest that firms can reduce the likelihood of incurring financial distress by maintaining a strong liquidity position This can be achieved by restricting the dividend payout or by holding high levels of cash and marketable securities, so that the propensity to hedge is negatively related to measures of short-term firm liquidity. Empirical evidence on liquidity and exchange exposure is mixed. Consistent with optimal hedging theory, He and Ng (1997) find a significant positive relation between the quick ratio and exchange exposure and an inverse relation between exposure and the dividend payout ratio. Muller and Verschoor (2006b) find a negative but insignificant coefficient on the quick ratio term, but their finding on dividends being negative related to exposure is stronger. We use the quick ratio[7] as the measure of short-term firm-level liquidity, and the dividend payout ratio[8].

5.3 Firm-level pooled cross-sectional regression results

Table 5 presents summary information for the country and firm-level variables that we use in our cross-sectional analysis. Panel A contains summary statistics and Panel B presents Spearman rank correlations. The market-to-book ratio, quick ratio and market value variables are highly skewed to the right, so we take the natural log of these in our multivariate analysis. For the debt-to-assets, market-to-book and quick ratios, Eurozone firms are no different from non-Eurozone firms, but non-Eurozone firms pay higher dividends than Eurozone firms, and this is significant using a Wilcoxon paired rank sum test ($p = 0.00$). This may in part explain why non-Eurozone firms have lower exposure; hedging theory suggests that firms with a high dividend payout

[6] Market-to-book is Datastram code MTBV.

[7] The quick ratio is Datastream code wc08101.

[8] The dividend payout ratio is Datastream code POUT.

should have a strong incentive to hedge. Non-Eurozone firms are also larger by market value (p = 0.03), and the Eurozone sample contains a larger proportion of small firms than non-Eurozone (45 percent versus 39 percent). The fact that more Eurozone firms are small may also provide a partial explanation as to why Eurozone firms have higher exposure than non-Eurozone.

Using our measure for trade openness in which we have adjusted the Eurozone countries' openness figures to reflect extra-Eurozone openness only (see footnote 4), we find that non-Eurozone countries are significantly more open than Eurozone. Generally speaking, non-Eurozone countries have better shareholder and creditor rights than Eurozone. This is particularly the case with shareholder rights; Norway, Sweden and the UK have high scores on shareholder rights, whereas Belgium, Germany and Italy score very low on this measure of governance. The Spearman rank correlations in Panel B of Table 5 show relatively low correlations between the variables, which provides comfort regarding multicollinearity.

We estimate the following equation:

$$\psi_i = \lambda_0 + \lambda_1 OPEN_{j,i} + \lambda_2 SHR_{j,i} + \lambda_3 CR_{j,i} + \lambda_4 MV_i + \lambda_5 MVDUM_i \qquad [3]$$

$$+ \sum_{k=1}^{10} \lambda_6^k INDDUM_i^k + \lambda_7 DA_i + \lambda_8 MTB_i + \lambda_9 QR_i + \lambda_{10} DIV_i + \lambda_{11} EURDUM_i + \varepsilon_i$$

Here, $\psi_i = \sqrt{|\alpha_2^i|}$, with α_2^i estimated via equation [1]. As well as taking their absolute values, it is necessary to further transform the exchange response coefficients α_2^i because taking the absolute value causes truncation bias, resulting in a non-normal error term. Following Dominguez and Tesar (2006), we transform the firm-specific absolute exchange response coefficients by taking their square root. $OPEN_{j,i}$, $SH_{j,i}$ and $CR_{j,i}$ are trade openness, shareholder rights and creditor rights for country (j) in which firm i is listed. MV_i, is the size of firm i as measured by market value and $MVDUM_i$, which is a dummy variable that takes the value of 1 for firms with a market value of less than US$150 million and zero otherwise, and $INDDUM_i^k$ (k = 1-11) refers to the industry dummies. DA_i is the average debt-to-assets ratio for firm i, MTB_i is firm i's average market-to-book ratio, QR_i is firm i's average quick ratio and DIV_i is firm i's dividend payout ratio. Because they are skewed to the right, we take the natural log of the variables *MV*, *MTB* and *QR*. Finally, $EURDUM_i$ is a dummy variable equal to one for firms in Eurozone countries and zero for firms in non-Eurozone countries.

Our results from estimating equation [3] can be found in Table 6.[9] We estimate the equation twice; first on the full data set of 1,147 firms, and then using a restricted data set that includes only those firms for which we found a significant (at the 10 percent level or better) exchange exposure coefficient α_2^i in equation [1]. The first point to note about our multivariate findings is the improved explanatory power when restricting the data set to include the significant exposure coefficients only; the adjusted R-sq rises from 0.08 percent for the full sample to 0.32 for the restricted sample regression. It is also important to note that the findings change little when the data set is restricted, and this gives us confidence about the robustness of our results. We find that after controlling for several country- and firm-specific factors, there is essentially no difference between Eurozone and non-Eurozone firm-level exchange exposure; in both regressions the Eurozone dummy is not significant (p = 0.26 and 0.32).

Three of our firm-level dependent variables – market-to-book ratio, dividend payout ratio and firm size – are strongly significant determinants of firm-level exchange exposure. Consistent with many prior studies (Chow, Lee and Solt, 1997; Bodnar and Wong, 2003; Hunter, 2005; Dominguez and Tesar, 2006), smaller firms are significantly more exposed than large, and the coefficient on the size dummy variable relation is stronger for firms with a market value of less than US$150 million (although this is significant only at the 10 percent level for the full data set). The dividend payout ratio is significantly inversely related to exchange exposure, and this is consistent with optimal hedging theories. Firms with a low dividend payout ratio are conserving short-term liquidity and so have less need to hedge, in which case they experience greater levels of exchange exposure. This is consistent with Nance, Smith and Smithson's (1993) idea that a larger short-term liquidity position mitigates the expected costs of financial distress and can therefore be seen as a substitute for hedging. Unfortunately the sign on the quick ratio variable is also negative, and this is opposite to the prediction of optimal hedging theory, although it is not significant in either specification. Creditor rights is significant and negative in the full sample regression, implying that shareholders of firms in countries with strong creditor protection face high bankruptcy costs, and that managers hedge risks in order to reduce the likelihood of bankruptcy. The coefficient is the same but is not significant in the restricted sample regression. Lastly, openness is not significant in either regression. Recall that for the Eurozone countries, trade openness is adjusted to remove intra-Eurozone trade from the overall openness figure. Our

[9] For the sake of brevity the industry coefficients are not reported in the table. None were found to be significant, and their presence added little power to the regressions.

finding is perhaps not surprising given that measuring openness in this way resulted in the Eurozone countries' openness figures being lower than non-Eurozone openness – thus contributing nothing to explaining why Eurozone firms' exposure is higher.

6. Concluding comments

In this paper we have examined the exchange exposure experience of 1,147 firms in 7 Eurozone and 4 non-Eurozone European countries before and after the introduction of the single currency. Using univariate tests, we find that Eurozone firms' exchange exposure is significantly greater than that of non-Eurozone firms. We also find that although exchange exposure increased from the pre-euro to the post-euro period for firms within and outside the Eurozone, the increase was smaller for the former than for the latter. Our finding that foreign exchange exposure has risen for Eurozone firms suggests that there may be some effect operating at the level of the market. In order to investigate this, we examined whether there is any difference between the extent to which stock market returns are affected by exchange rate changes before and after the introduction of the euro. We find that market-level exposures have declined within the Eurozone by more than they have outside it. Finally, we have examined a set of country-level and firm-level variables to address the question of why Eurozone firms are more exposed than non-Eurozone firms. When we control for these variables, there is no difference between the exposure of Eurozone firms and those in our four non-Eurozone European countries.

The elimination of risk for intra-Eurozone transactions has been touted as an important benefit of Eurozone membership. While it is unquestionable that intra-Eurozone transactions are no longer associated with exchange risk, there has been very little empirical analysis examining the exchange exposure experience of Eurozone firms. Our finding that Eurozone firms' exposure increased less than non-Eurozone firms provides evidence that Eurozone membership has indeed provided some protection from higher foreign exchange exposure that has been borne by European firms in general. Finally, lower market-level exposure has helped to offset higher firm-level exposure. Our findings are consistent with the notion that the advent of the euro has been associated with a shift in exchange risk from systematic to firm-specific amongst Eurozone firms.

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Table 1 Exchange rate volatility and exchange rate arrangements

	Pre-euro		Post-euro		Exchange rate arrangements
	Mean	SD	Mean	SD	
Eurozone countries					
Belgium	0.04	0.78	0.04	0.67	Eurozone[a]
France	0.07	0.78	0.04	0.68	Eurozone[a]
Germany	0.08	0.93	0.06	0.83	Eurozone[a]
Italy	-0.21	1.84	0.08	0.74	Eurozone (ERM 1979 to 1992, euro 1999)
Netherlands	0.02	0.76	0.04	0.73	Eurozone[a]
Portugal	-0.06	0.93	0.03	0.43	Eurozone (ERM 1992, euro 1999)
Spain	-0.23	1.15	0.03	0.49	Eurozone (ERM 1989)
Average	**-0.04**	**1.02**	**0.05**	**0.65**	
Non-Eurozone countries					
Norway	-0.09	0.99	0.13	1.42	Independent float (fixed to 1992; managed float 1992 to 2001)
Sweden	-0.22	1.75	0.01	1.29	Independent float (fixed to 1991; ERM 1991-92)
Switzerland	0.12	1.40	0.05	1.03	Independent float (1973)
UK	0.03	1.75	0.01	1.16	Independent float (managed float to 1990, ERM 1990-92)
Average	**-0.04**	**1.47**	**0.05**	**1.23**	

Notes. This table presents summary statistics for the exchange rates, and provides a brief summary of the exchange rate arrangements over the sample period. The data are monthly IMF trade-weighted exchange rates sourced from Datastream. The means and standard deviations of the log change in the exchange rates are reported in the table. The pre-euro period runs from January 1990 to December 1998, and the post-euro period begins January 1999 and ends January 2008.

Table 2 Firm-level exchange exposure response coefficients

		Pre-euro period						Post-euro period							
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
	N	no. neg	no. signif	% signif	sig pos	sig neg	median abs	no. neg	no. signif	% signif	sig pos	sig neg	median abs	post– pre euro median	p-value
Eurozone firms															
Belgium	38	26	6	15.8	3	3	0.85	10	4	10.5	4	0	0.78	-0.07	0.70
France	174	91	12	6.9	6	6	0.79	73	15	8.6	15	0	0.83	0.04	0.83
Germany	256	149	14	5.5	3	11	0.54	113	23	9.0	17	6	0.79	0.25	0.00
Italy	88	42	8	9.1	5	3	0.3	42	8	9.1	5	3	0.57	0.27	0.00
Netherlands	68	41	12	17.6	3	9	0.83	30	7	10.3	3	4	0.78	-0.05	0.89
Portugal	34	16	3	8.8	2	1	0.77	15	3	8.8	2	1	2.42	1.65	0.01
Spain	44	17	4	9.1	2	2	0.56	20	4	9.1	3	1	0.88	0.32	0.02
Eurozone total	702	382	59	8.4	24	35	0.58	303	64	9.1	49	15	0.8	0.22	0.00
Non-Eurozone firms															
Norway	29	14	3	10.3	1	2	1	18	5	17.2	0	5	0.61	-0.39	0.05
Sweden	63	27	5	7.9	2	3	0.46	43	3	4.8	0	3	0.46	0.00	0.73
Switzerland	98	96	32	32.7	2	30	1.02	79	26	26.5	0	26	1.2	0.18	0.06
UK	262	87	22	8.4	18	4	0.32	73	24	9.2	22	2	0.66	0.34	0.00
Non-Eurozone total	452	224	62	13.7	23	39	0.46	213	58	12.8	22	36	0.66	0.20	0.00
Sample overall	**1154**	**606**	**121**	**10.5**	**47**	**74**	**0.53**	**516**	**122**	**10.6**	**71**	**51**	**0.72**	**0.19**	0.00

Notes. This table summarises information on the exchange rate response coefficients α_2^i from estimating equation (1). Separated into pre-euro and post-euro periods, we present for each country and for the Eurozone countries, the non-Eurozone countries, and the sample overall, the number of firms, *N*, the number negative, the number and percent significant, the number significantly positive and negative, and the median absolute α_2^i. Column [14] presents the difference in the median absolute α_2^i between the post and pre-euro period, and [15] contains the p-value for the associated Wilcoxon rank sum test of difference.

Table 3 Market exchange exposure

	Pre-euro period					Post-euro period				
	β_1^j	p-value	R-Sq	Var s_t^j	Covar	β_1^j	p-value	R-Sq	Var s_t^j	Covar
Belgium	-2.459	0.00	0.15	0.61	-1.49	0.641	0.31	0.01	0.45	0.29
France	-2.843	0.00	0.14	0.61	-1.72	-1.015	0.19	0.02	0.47	-0.47
Germany	-1.957	0.00	0.11	0.87	-1.68	-0.991	0.22	0.02	0.68	-0.67
Italy	0.655	0.02	0.03	3.38	2.19	-0.729	0.26	0.01	0.54	-0.39
Netherlands	-3.027	0.00	0.20	0.57	-1.72	-0.956	0.19	0.01	0.53	-0.50
Portugal	-1.016	0.06	0.02	0.86	-0.87	-0.853	0.34	0.01	0.18	-0.15
Spain	-0.295	0.63	0.00	1.32	-0.39	-1.794	0.11	0.03	0.24	-0.43
Norway	-0.359	0.67	0.00	0.99	-0.35	-0.051	0.88	0.00	2.03	-0.10
Sweden	-0.548	0.32	0.02	3.07	-1.67	0.411	0.30	0.01	1.65	0.67
Switzerland	-0.628	0.10	0.03	1.93	-1.20	-1.252	0.01	0.09	1.35	-0.17
UK	-0.120	0.71	0.00	3.05	-0.36	-0.126	0.65	0.00	0.97	-1.20

Notes. This table presents the findings for the relation between each country's local currency monthly log difference stock market return (R_t^j) and the log difference change in its trade-weighted exchange rate (s_t^j). β_1^j is the exchange response coefficient for country *j* estimated via equation [2]. The associated p-value and the R-sq for the equation are reported in the adjacent columns. In this table we separate β_1^j into its constituent parts Cov (s_t^j, R_t^j) and Var (s_t^j). The pre-euro period runs from January 1990 to December 1998, and the post-euro period begins January 1999 and ends January 2008.

Table 4 Industry information

	N	Count		Proportion of sample		Absolute α_2^i	
		Eurozone	Non-Eurozone	Eurozone	Non-Eurozone	Mean	Median
Chemicals	77	24	53	0.05	0.08	0.93	0.59
Commodities and metals	32	10	22	0.02	0.03	0.82	0.49
Construction and building products	58	16	42	0.04	0.06	0.91	0.80
High-tech manufacturing	94	41	53	0.09	0.08	1.34	1.04
Low-tech durables manufacturing	299	119	180	0.26	0.26	1.10	0.69
Non-durables manufacturing	89	27	62	0.06	0.09	0.78	0.54
Services	185	80	105	0.18	0.15	1.23	0.90
Textile, clothing and footwear	56	15	41	0.03	0.06	1.21	0.78
Telecoms, media and information	54	24	30	0.05	0.04	1.08	0.81
Utilities	89	36	53	0.08	0.08	0.76	0.51
Wholesale, retail and transportation	121	60	61	0.13	0.09	1.01	0.64
	1154	**452**	**702**				

Notes. This table summarises industry affiliation. The table details the number of firms Our 11 industries are based on the NAICS codes, as follows: chemicals 325 and 326; commodities and metals: 11-21 and 331; construction and building products: 23 and 327; high-technology manufacturing 334-335 and 3364 (aerospace); low-technology durables manufacturing: 321-324, 331-333, 336-339; non-durables manufacturing: 311 and 312; services: 52-92; textile, clothing and footwear: 313-316; telecoms, media and information: 51, utilities: 22, wholesale, retail and transportation: 42-49.

Table 5 Summary information – dependent variables in the multivariate analysis

	Eurozone			Non-eurozone			
	Mean	Median	Skew	Mean	Median	Skew	p-value
Panel A: Summary statistics							
Debt-to-assets	0.28	0.25	0.60	0.27	0.25	0.59	0.85
Market-to-book	2.90	1.50	11.59	2.76	1.38	14.06	0.31
Quick ratio	1.52	0.92	21.43	1.26	0.96	15.96	0.69
Dividend payout (%)	31.62	29.82	0.46	36.35	37.69	0.06	0.00
Market value	2437.6	159.2	6.4	2898.3	221.3	8.9	0.03
Proportion small	0.45			0.39			
Openness	36.42	38.13		69.06	58.43		0.00
Shareholder rights	1.82			4.01			0.00
Creditor rights	1.82			2.94			0.00

Panel B: Spearman rank correlations

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Debt-to-assets	1	0.05	-0.38	-0.09	0.20	-0.03	-0.12	-0.13
2. Market-to-book		1	0.00	0.01	0.38	0.01	-0.15	0.04
3. Quick ratio			1	0.00	-0.02	0.02	-0.16	-0.11
4. Dividend payout ratio				1	0.27	-0.01	0.00	0.15
5. Market value					1	0.03	0.00	-0.07
6. Openness						1	0.10	0.20
7. Shareholder rights							1	0.27
8. Creditor rights								1

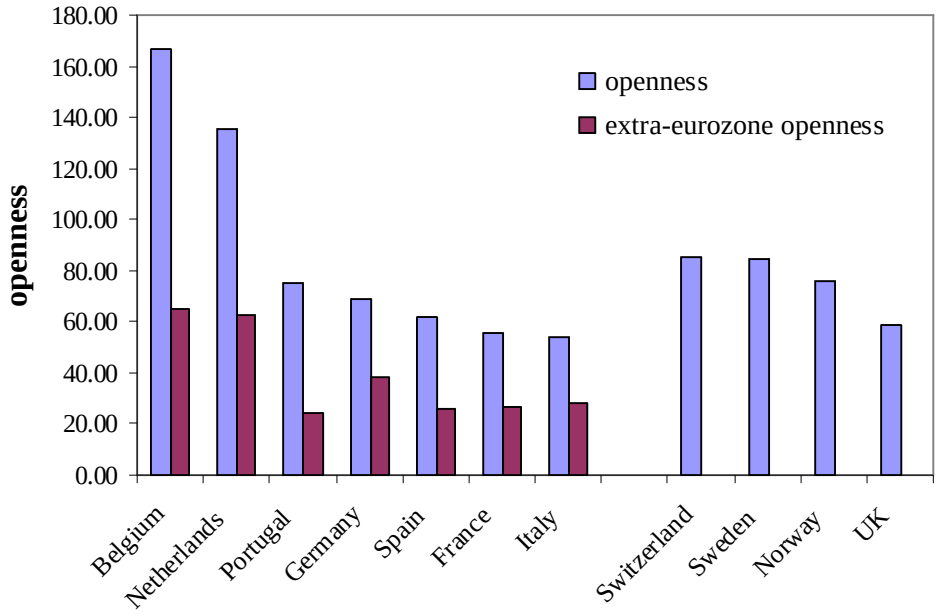
Notes. In this table we present summary data on the dependent variables that we use in the multivariate analysis, separately for the Eurozone and non-Eurozone firms. The financial ratio variables are drawn from Hutson and Kearney (2008) and they are averages for the period 1999-2003. *Market value* is market capitalisation in US dollars at the end of 2003. *Openness* is average trade openness for each country drawn from the Penn World Table Version 6.2, for the period 1999-2004 (from Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006; http://pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php), with the Eurozone countries' openness figures adjusted to reflect extra-Eurozone trade only (see footnote 4 for details). The column headed *p-value* is the p-value for a Wilcoxon rank sum test for difference between each variable Eurozone and non-Eurozone countries. Panel B presents the Spearman rank correlations for the same variables.

Table 6 Multivariate analysis results

	Full data set (n = 1,154)	**Restricted data set (n = 208)**
Constant	1.110 (0.00)	1.912 (0.00)
Debt-to-assets	0.079 (0.23)	0.068 (0.50)
Market-to-book	0.045 (0.01)	0.020 (0.00)
Quick ratio	-0.029 (0.17)	-0.013 (0.16)
Dividend payout ratio	-0.003 (0.00)	-0.004 (0.00)
Market value	-0.047 (0.00)	-0.054 (0.00)
Size dummy	-0.075 (0.09)	-0.029 (0.69)
Openness	0.001 (0.64)	-0.003 (0.33)
Shareholder rights	0.014 (0.40)	0.018 (0.54)
Creditor rights	-0.024 (0.04)	-0.024 (0.20)
Eurozone dummy	0.099 (0.26)	0.152 (0.32)
Adj. R-sq.	0.08	0.32

Notes. This table presents the results for our pooled regression analysis of equation [3]. The dependent variable is the exchange exposure of firm *i*, as measured by $\sqrt{|\alpha_2^i|}$ (with α_2^i estimated via equation [1]). This model is first estimated on the full data set with n = 1,154 and then on a restricted data set, comprising those firms for which α_2^i is significant at the 10 percent level or better.

Figure 1 Economic openness



Notes. This figure presents the average economic openness measures for the period 1999-2004. *Openness* is exports plus imports over GDP, and is drawn from Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006. *Extra-Eurozone openness* is calculated by taking the Penn data and adjusting it to reflect the proportion of extra-Eurozone trade using trade data from the Eurostat statistical yearbook *External and intra-European trade, data 1958-2006*. More detail about how this was done can be found in footnote 4.